Does BMI moderate the effects of social cues on snacking?

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I declare that this report is my own original work and that contributions of others have been duly acknowledged.

Signature:…….. ***Date:……..***

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Abstract

The aim of the present study is to investigate BMI as a predictor of the likelihood that social cues effect snacking behaviour. Increased BMI is associated with increased impulsivity and poor self-regulation. Snacking in a social context is largely ambiguous so overweight and obese individuals rely on social norms to guide their eating behaviours to manage the impression others have of them. Therefore, it is expected that BMI will moderate the effects of social cues on snacking. More specifically it is hypothesised that BMI will moderate the effect of seeing others eating on snacking. When overweight and obese individuals lack a social reference their behaviour will reflect impulsivity eating behaviour. As such, it is also hypothesised that BMI will moderate the effect of being alone on Snacking. Over a 14-day period, 112 non-clinical individuals from the general population used Ecological Momentary Assessment (EMA) devices to record their eating behaviours and social surroundings in real-time. As hypothesised, BMI moderated the effects of social cues on snacking. Participants with a higher BMI were more likely to consume low-energy snacks when others were eating compared to participants with a lower BMI. Participants with a higher BMI were more likely to consume high-energy snacks when alone than participants with a lower BMI. This indicate that BMI moderates the relationship of social influences on snacking behaviour.

Obesity is a growing concern for Australia. The rate of overweight and obese individuals is increasing as too are the number of associated chronic illnesses (WHO, 2000). This is placing strain on the resources and finances of the public health system (Colagiuri et al., 2010). The rapid increase in obesity has been attributed in part to the change in the food environment. Food is easily available with an abundance of choice and is combined with a sedentary lifestyle (Chaput, Klingenberg, Astrup, & Sjodin, 2011; Thomas, Doshi, Crosby, & Lowe, 2011). This often leads to an energy imbalance where people are consuming more energy than they are expending (Hendrikse et al., 2015). However, some individuals manage to maintain a healthy energy balance irrespective of the obesogenic food environment (Stok et al., 2015).

Examining individual differences between high and low BMI groups will provide insight into possible mechanisms of obesity. Previous research indicates that individuals with a higher BMI consume more discretionary foods that are high in fat, salt and sugar compared to individuals with a lower BMI (Hendrie, Baird, Golley, & Noakes, 2016). Discretionary foods are consumed ab lib so consumption is vulnerable to social influence (Cleobury & Tapper, 2014). It is believed that increased BMI is associated with executive functioning deficits, responsible for self-regulation and decision making (Jasinska et al., 2012). Individuals with a higher BMI lack the ability to self-regulate their intake of discretionary foods and rely on social normative cues to guide their eating behaviour (Graham, Gluck, Votruba, Krakoff, & Thearle, 2014).

The literature describes three theories to explain social influences on eating behaviour. Social modelling is the imitating of others eating behaviour as it is deemed socially accepted (Herman, Roth, & Polivy, 2003). Social facilitation refers to an elicited increase in consumption of energy by the presence of other, usually family or friends (Salvy, Jarrin, Paluch, Irfan, & Pliner, 2007). If an individual feels they are being observed and

judged, usually by a stranger they engage strategies to manage the impression they give that person. This usually involves restricting eating and choosing healthier food options (Cheng, Huang, Chuang, & Ju, 2015). Due to the burden obesity is placing on the public health system and the sever health implications individuals face, it is imperative to further explore underlying mechanisms such as differential responses to social eating cues.

Obesity

Obesity is one of the leading risk factors for avoidable premature death in Australia (AIHW, 2014). WHO (2000) has described obesity as abnormal or excessive fat accumulation in the body commonly measurement by Body Mass Index (BMI), a measure of the relationship between a person's height and weight. Individuals who have a BMI equal to or above 25 are categorised as being overweight, and a BMI 30 or above is obese (WHO, 2000). Increased BMI is associated with chronic illness, such as Type 2 diabetes, cardiovascular disease, high blood pressure, bowel cancer, sleep apnoea, osteoarthritis, as well as psychological and social problems, these are often comorbid and result in premature death (WHO, 2000). The proportion of over-weight and obese Australians has increased to over half of the population; 63.4% which is equivalent to 11.2 million people nationally (ABS, 2015). The epidemic proportions of over-weight and obese Australians is placing strain on the public health system and the total costs of obesity have been estimated at 56 billion dollars annually (Colagiuri et al., 2010). Due to the physical, psychological and social problems associated with high BMI, as well as the strain on the public health system, it is imperative to understand the mechanisms associated with high BMI, in order to guide health interventions.

Weight gain occurs when energy consumed exceeds energy expended, resulting in an energy imbalance (Hendrikse et al., 2015; Prentice & Jebb, 2004). The body

attempts to regulate energy with internal homeostatic feedback mechanisms such as hunger and satiety. However, these mechanisms only function effectively within the context of limited food resources that they were developed (Prentice & Jebb, 2004). The current food environment is often referred to as the obesogenic environment. It describes an increased omnipresence and availability of palatable high energy foods (Stok et al., 2015). An energy imbalance is usually a result of overconsumption of discretionary foods, which are high in fat, sugar and salt (Sui, Wong, Louie, & Rangan, 2016).

Some individuals manage to maintain a healthy energy balance irrespective of the obesogenic food environment (Stok et al., 2015). Individuals with a higher BMI consume more energy than normal-weight individuals (Forslund, Torgerson, Sjostrom, & Lindroos, 2005). A recent report published by the CSIRO revealed a difference in the diets of normal-weight and obese individuals. The results suggested the high BMI group had a higher discretionary food intake than the low BMI group (Hendrie et al., 2016). Schachter (1968) externality hypothesis provides a theoretical explanation for these findings. He suggests that individuals with a high BMI are less responsive to internal cues and more responsive to external cues.

Internal Cue Responsiveness

Individuals with a higher BMI are less responsive to internal cues of hunger and satiation. Schachter (1968) provided participants with sandwiches prior to a mock taste testing in a technique called preloading. Following preloading it can be assumed that participants are satiated. They found that overweight and obese individuals consumed more than normal-weight participants in the taste test despite being satiated. Schachter (1968) concluded that eating behaviours of overweight and obese individuals appear to be less influenced by internal eating cues and more influenced by external cues. This provides some

explanation for why high BMI individuals overeat in response to the obesogenic environment (Stroebe, van Koningsbruggen, Papies, & Aarts, 2013)

fMRI studies supported Schachter (1968) hypothesis by demonstrating an increased reactivity to energy dense foods within brain regions that respond to food cues in high BMI participants (Stice, Spoor, Bohon, Veldhuizen, & Small, 2008). This suggests that overweight and obese individuals are more likely to consume discretionary foods due to an expectation of pleasure upon consumption (Stroebe et al., 2013). As seen in drug addiction studies, to reach that same level of pleasure beyond satiety individuals need to consume more energy dense foods in order to experience the same level of reward sensation. Consequently, this leads to overconsumption and a positive energy imbalance (Stroebe et al., 2013).

External Cue Responsiveness

Individuals with a higher BMI have an increased responsiveness to cues unrelated to hunger and satiation. Research suggests overweight and obese individuals overconsume energy partly as a result of increased cue sensitivity and slower habituation (Werthmann et al., 2011). Heightened cue senstivity is a form of conditioned response where a food cue simulates the same physiological response present at food consumption, which is then misinterpreted as homeostatic hunger (Tetley, Brunstrom, & Griffiths, 2009). Overweight and normal-weight individuals also appear to differ on the length of time it takes to habituate towards a food cue (Epstein et al., 2008). Habituation is the reduction of physical and behavioural responses to a stimuli following multiple exposures. The longer someone takes to habituate to a food stimulus the more energy they consume (Temple, Giacomelli, Roemmich, & Epstein, 2007).

Snacking choices are less of a conscious decision and more influenced by external cues (Cleobury & Tapper, 2014; Salmon, Fennis, de Ridder, Adriaanse, & de Vet, 2014).

Discretionary foods lack the normative constraints to guide appropriate consumption behaviour that are inherit to meal times, such as severing size and food type (Wansink, Payne, & Shimizu, 2010). In social situations individuals with a higher BMI rely on normative eating behaviours of others to guide their discretionary food intake (Maykovich, 1978). Cleobury and Tapper (2014) examined the self-reported reasons for eating high-energy snacks and low-energy snacks in overweight and obese participants. They found that external cues were the most frequently reported prompt of snacking behaviour. High-energy snacks were consumed due to the high temptation from external cues such as smell and sight. Although less low-energy snacks were consumed, the reasons for consumption were the same. Increased sensitivity and slower habituation increase the salience of external eating cues, maximising the likelihood of consumption (Epstein et al., 2008).

Self-Regulation

Surrounded by discretionary foods with a heightened sensitivity towards food cues requires continuous self-regulation to override unconscious eating impulses (Bongers et al., 2015). It has been suggested that high BMI is associated with an executive function deficit. This makes it more difficult for overweight and obese individuals to resist food cues and self-regulate impulsive eating behaviours (Graham et al., 2014). To effectively self-regulate eating behaviour, individuals must have a goal that they behaviour in alignment with (De Ridder, De Vet, Stok, Adriaanse, & De Wit, 2013). These goals are developed based on a stereotype that is perceived to be socially accepted. Vartanian, Herman, and Polivy (2007) conducted a review of the consumption stereotype literature and reported various stereotyped images conveyed through eating behaviours. For instance, energy dense foods are perceived to be related to being unhealthy and overweight. While low-energy foods are perceived to be associated with a good health and a slim figure.

Individuals behave in line with behaviours attributed to the positive stereotype in order to portray a positive social image (Campbell & Mohr, 2011). If someone is present that fits with an ideal stereotype the eating behaviours of that person will provide a guide for of acceptable behaviour. Hence, the behaviour of others can be a self-regulatory mechanism to avoid overconsumption (Vartanian et al., 2007). Depending on the comparison of the stereotype goal and others present will depict if the individual eats less, more or the same amount (Herman et al., 2003). Salmon et al. (2014) suggested that participants with low self-regulation choose more unhealthy options compared to high self-regulation participants when a social norm was not present or ambiguous. However, when the social norm was obvious the low self-regulatory group made healthier food choices in line with the heuristic (Salmon et al., 2014).

Social Cues

The presence of others eating may facilitate or inhibit what and how much a person chooses to eat (Cheng et al., 2015). Two studies conducted by Leone, Pliner, and Herman (2007) highlighted the influence of social norms on facilitation and inhibition of eating behaviours. They found that when normative cues were ambiguous participants were less likely to inhibit their eating behaviours. When acceptable normative behaviour was clear the participants reduced their consumption in line with confederate. In the literature there are three social pathways that the presence of others can influence eating behaviours; social modelling, social facilitation and impression management.

Social modelling refers to the change in eating behaviour to match that of an eating companion. Herman et al. (2003) suggested that others eating is a guide to what and how much is socially accepted within that context. A systematic review of the current social modelling literature suggests that modelling behaviour occurs because individuals seek

normative information as a way to affiliate with others that fit with their ideal stereotype (Cruwys, Bevelander, & Hermans, 2015). Shimizu, Johnson, and Wansink (2014) explored the effects of a companion's weight on healthy and unhealthy food choices. A confederate was either wearing an overweight prosthesis or not and either served herself unhealthy pasta or healthy salad. The results demonstrated participants serving and eating more amounts of unhealthy pasta when the confederate was wearing the prosthesis. When she served herself salad, participants served and ate smaller amounts of salad than the confederate. Shimizu et al. (2014) argue that that a companion's body weight influences eating behaviour because people are motivated to portray a favourable identity to others. Therefore, they either model the behaviour or do the opposite depending on the affiliation.

Social facilitation of eating refers to the increased and encouraged consumption when in the presence of others (Herman et al., 2003). Zajonc (1965) identified two types of social facilitation; audience effects are when people are eating in the view of others, and co-action effects where people are eating together. People are socially facilitated to eat more in the co-action scenario compared to social suppression of eating in the audience scenario (Herman, 2015). de Castro (1994) found that people consume 44% more when eating with others compared to eating alone. Meals eaten with family were larger and eaten quicker whereas, meals with friends were also larger but consumed slower. de Castro (1994) concluded that eating with others facilitates consumption amount by increasing the time spent eating and consequently increasing the amount of energy consumed (de Castro, 1994). Salvy, Jarrin, et al. (2007) supported and added to these findings by suggesting that individuals are socially facilitated to eat when eating with others known to them such as family and friends.

In contrast eating behaviours are inhibited and less energy is consumed when strangers are present (Salvy, Jarrin, et al., 2007). In order to gain social approval individuals manage the impression others have of them by reflecting socially normed eating behaviours

(Polivy & Pliner, 2015). Impression management begins with a social comparison to either a preconceived idea or observed behaviour of an individual who represents an attainable goal (Festinger, 1954). Cheng et al. (2015) predicted that participants would impression manage by controlling food intake when people are observing and judging their behaviour. They found that participants made personal preference choices of high-energy discretionary foods when alone and free of public scrutiny. In line with impression management theories participants choose the healthier options when choices were made public.

BMI and Social Cues

The presence of others can affect the eating behaviours of people differently. Several studies have noted a difference in the eating behaviours between high and low BMI groups. For example Salvy, Romero, Paluch, and Epstein (2007) examined the influence of peer presence on snacking intake between girls with high and low BMI. They found that the higher BMI group altered their eating behaviours to match the eating companion. Hence, they consumed more energy when eating with another high BMI individual compare to eating with low BMI companion. Lower BMI participants eating behaviours did not significantly vary between eating companions. These findings a suggestive of a differences in social cue response on eating behaviour between BMI ranges.

Maykovich (1978) explored the effect of social influence on normal-weight and obese participants. He found that obese individuals ate less when eating in a group including normal-weight individuals compared to when they ate alone or with other obese people. Maykovich (1978) argued that the presence of normal weight individuals makes obese individuals self-conscious of their eating behaviours. These social influence effects are only seen in obese individuals and not in normal-weight comparisons (Herman, 2015). A review of social eating context literature is revealed overweight individuals eat substantially more

when in the company of another overweight person compared to eating with a individual in the normal-weight range. This effect was only seen in obese individuals, with normal-weight individuals remaining unaffected (Polivy & Pliner, 2015).

Rationale and Hypothesis

Discretionary foods are the main source of excessive energy consumption (Sui et al., 2016). It is imperative that influential factors of excessive energy consumption are identified as such factors may underpin the successful development of interventions. Eating often occurs within a social context, we need to learn more about how and why and with whom social cues work more strongly. As executive functioning has been shown to vary across BMI ranges social cues on snacking should be examined across BMI in order to detect any variance in effects.

Ecological momentary assessment (EMA) methods allow data collection to occur in real time. This includes thorough assessment of the food consumed as well as the surroundings at the time the decision to eat was made. Specifically, a picture of the social context can be drawn from the information provided. EMA methods overcome the limitations of traditional methods such as poor recall and biased reports (Thomas et al., 2011)

The aim of the present study is to investigate BMI as a predictor of the likelihood that social cues effect snacking behaviour. Increased BMI is associated with poor executive functioning exhibited in increased impulsivity and poor self-regulation. Snacking in a social context is largely ambiguous so overweight and obese individuals rely on social norms to guide their eating behaviours to manage the impression others have of them. Therefore, it is expected that BMI will moderate the effects of social cues on snacking. More specifically it is hypothesised that BMI will moderate the effect of seeing others eating on snacking. When overweight and obese individuals lack a social reference their behaviour will reflect

impulsivity eating behaviour. As such, it is also hypothesised that BMI will moderate the effect of being alone on Snacking.

Method

Overview

The data from the current analysis are from two studies from two EMA studies involving social factors that cue snacking behaviour, and BMI as a moderator in these relationships. The two studies used the same method and procedure. Participants were recruited using the same inclusion criteria except for BMI range. Study 1 recruited individuals with a BMI above 25 and study 2 included individuals with a BMI between 18 to 40. By combing the two date sets the current study had a broad range from normal to obese to compare and examine the differences in snacking behaviours between high and low BMI. Data was collected in a two stage process with participants recording all food and beverages consumed over a 14-day period. In the second stage, a subset of these reports were selected for full assessment of the internal and external cues present at the time the decision was made to snack. In order to have a comparison to times of consumption, participants were asked to respond to internal/external cue assessments randomly administered up to five times during the day. All assessments were administered and responded to on a customised hand-held smartphone device, which has been validated in previous research on eating behaviour. Established protocols were used in training participants to use the EMA technology (Shiffman, Stone, & Hufford, 2008)

Participants

The current study sample consisted of 122 adults (77 females, 68.75%), aged 18 to 73 (M= 35, SD=14.1), recruited from the general population via media and social media

releases. Participant eligibility requirements for both studies were the same except for the BMI ranges, study 1 recruited participants with a BMI above 25 and study 2 recruited participants within the BMI range 18 to 40. Both studies included participants who were not trying to change or restrict eating behaviours at the time (e.g. dieting), had no history of an eating disorder and were above the age 18 with study 2 limiting the intake to 65years. Height and weight measurements were provided at screening, enabling a body mass index (BMI) score to be calculated. Participants BMI ranged between 18.34 and 45.71 (M=27.61, SD=5.29). Participants who completed the study received AU$50 compensation for time and travel expenses. Such compensation has been shown to promote adherence to EMA protocols in related research.

Table 1

Participant Descriptives

	Overall	Study1	Study 2
No. Participants	112	51	61
Sex (% female)	77 (68.75)	34 (66.66)	42 (68.90)
Age Range (*M*,*SD*)	18 – 73 (*M*=35, *SD*=14.1),	19 - 73 (*M*=38.31, *SD=1*4.87)	18 - 64 (*M*=32.23, *SD*=12.90)
BMI Range (*M*,*SD*)	18.34 - 45.71 (*M*=27.61, *SD*=5.29).	23.83 - 45.70 (*M*=30.77, *SD*=4.85)	18.34 - 38.58 (*M*=24.94, *SD*=4.07)

Procedure

The Tasmanian Social Science Human Research Ethics Committee approved both studies (ethics reference number H0014439; H0015647). Study 1 collected data between April 2015 to July 2015 and Study 2 collected data between April 2016 to August 2016. Interested future participants contacted researchers, who conducted telephone screening prior to scheduling an enrolment visit. Written informed consent was received from each participant before they began involvement in the study.

Participants were required to attend three visits to the laboratory. During the initial enrolment visit (max. 45minutes), participants were asked to fill in a baseline questionnaire (see appendix) assessing sociodemographic information, as well as personal eating and drinking behaviour. These questionnaires additionally assessed personality traits via scales such as the Behavioural Activation/ Inhibition Scale (Carver & White, 1994); Centre for Epidemiological Studies Depression Scale (Radloff, 1977); the Power of Food Scale (Lowe et al., 2009); and the Yale Food Addictive Scale (Gearhardt, Corbin, & Brownell, 2009). These scales were not analysed in the present study.

Upon completion of the survey, participants were individually trained on use of the specifically programmed smartphone (EMA device). Instructions included using the EMA device to log every meal, snack and drink (excluding water), immediately before consumption. With subsequent questions regarding internal and external cues and food environment at the time the participant decides to eat. In order to have a comparison, participants were randomly prompted to answer the same questions up to five times a day, all of which were time and date stamped. Therefore, participants were required to have the device with them at all times during waking hours. Participants practiced responding to the assessments during this visit and were provided with an EMA instruction booklet.

Participants were directed to complete an evening report anytime between 7pm and midnight. The report included overall feelings for the day, exercise and cravings. Once the evening report was submitted, a bedtime/alarm option replaced it that stopped the device sending random prompts throughout the night. Following the alarm participants were required to complete a morning reports including questions of cravings, feelings and any food consumed since last reported.

Visit two (2) was held 2-3 days after the initial visit (approx. 15minutes), in order to monitor protocol compliance. Participants with compliance below 100% were retrained. The EMA device was uploaded and data reviewed with the participants. If required, additional training was provided and any technical issues were addressed. On visit three (3), 14 days' post enrolment participants returned to the laboratory with both device and charger. A short debrief regarding their experience was conducted and $50 compensation provided.

Assessment

Based on previous stimulus-control dietary behaviour research in a non-clinical population (Schuz, Bower & Ferguson, 2015), assessments were administered and responded to on an EMA smartphone device. The assessments varied across response types; quantitative, qualitative single response and qualitative multiple responses. Reports from both participant logging and randomly prompted requested information regarding individual, situational and contextual factors of interest.

Assessment of *external cues* mirrored previous dietary (Schuz, Bower, & Ferguson, 2015) and substance use EMA research (Ferguson & Shiffman, 2011). Social cues were assessed with questions such as 'when you decided to eat, were there other people eating?'. Responses were qualitative, including "no", "yes, in my view" and "yes, in my group".

Food reports were assessed following a two-stage procedure: Participants first self-reported whether they had a main meal or snack (Wansink et al., 2010) and were then asked to indicate the type of foods consumed. In the second stage, a subset of these reports were selected for full assessment of the internal and external cues present at the time the decision was made to snack. Upon completion of each report participants were given the opportunity to return and alter responses. Once the reports were submitted they were stored on the device until they were uploaded at the next scheduled visit. At each visit the EMA device data was uploaded to a secure server on a password-protected computer.

Analysis

Individual days identified as poor compliance with less than 50% random prompts completed will be removed prior to analysis. The primary objective of this study was to examine the influence of certain external cue on snacking. EMA data is hierarchical in nature, with repeated assessments nested under each participant. The likelihood that a specific report is a snack report or a random prompt was predicted from the presence of *others eating* or *being alone* in a multilevel logistic regression analysis. Both slopes and intercepts were allowed to vary, while pooling the resulting estimates (Snijders & Bosker, 2012). Both cues were examined separately for cross-level interactions between level 1 and level 2 factors, where level one factors were group mean centered and level 2 factors were grand mean centered (Enders & Tofighi, 2007). This procedure obtains both pooled estimates of the overall effects of the covariates and intercepts as well as estimates of the amount and significance of between-person variation in each effect. The analysis was run with HLM, using maximum likelihood estimation with robust standard errors (MLR). Snack reports will be classified as *high* or *low energy* based on the food group reported. Fruit and vegetable were considered *low energy* and all other groups considered *high energy* (confectionary,

dairy, biscuits, savoury), based on the energy and saturated fat content estimates of the Dietary Targets Monitor (Lean, Anderson, Morrison, & Currall, 2003).

Results

In total, there were 1599 days available for analysis, with each participant completing an average of 14 days of reporting (*M*=14.41, *SD*=2.75). Participants were randomly prompted to report an average of 2.69 (*SD*= 1.50) times a day. Through-out the study, 4062 random prompts were issued with participants completing 3960 of them. This resulted in an overall compliance rate of 97.49%, following the removal of 130 unsatisfactory (<50%) compliant days (Schuz et al., 2015). On average, participants consumed 2.24 (*SD*=1.03) meals a day, with a total of 1473 meals logged during the duration of the study. Participants reported snacking an average of 1.44 (*SD*=1.55) times a day. Of the snacks reported 1400 were high-energy and 1380 were considered low energy. Participants consumed on average more high-energy snacks (*M*=.90, *SD*=1.19) a day, compared to low-energy snacks consumed per day (*M*=.44, *SD*=.71). A correlation analysis (see Table 2) was conducted to examine the relationship between BMI and the number of high and low energy snacks consumed. Neither correlation coefficient for high or low energy snacks were significant. However, the direction of the correlations is indicative of an increase in BMI resulting in an increase in snacking consumption, especially for high-energy snacks.

Table 2

Correlation between BMI and number of Snacks

	High-Energy Snack	Low-Energy Snack	BMI
Pearson Correlation	.178	.042	1
Sig. (2-tailed)	.061	.660	
N	111	111	112

Note. Correlation is significant at the 0.05 level (2-tailed).

Table 3

Descriptive Statistic

	Overall	Study 1	Study 2
Days (*M*,*SD*)	1599 (*M*=14.41, *SD*=2.75).	745 (*M*=14.61, *SD*=1.46).	776 (*M*=14.87, *SD*=2.10).
RP Issued (*M* per day)	4062 (*M*=2.69)	1953 (*M*=2.62).	2374 (*M*=2.75).
RP Completed	3960	1861	2058
Compliance	97.49%	95.29%	86.69%
High-Energy Snacks (*M*, *SD* per day)	1400 (*M*=.90, *SD*=1.19)	(*M*=14.41, *SD*=2.75).	(*M*=1.3, *SD*=.75).
Low-Energy Snacks (*M*, *SD* per day)	1380 (*M*=.44, *SD*=.71).	(*M*=14.41, *SD*=2.75).	(*M=.65 SD=.48)*.

Snacking Cues

Initial multinomial logistic regression analysis was used to investigate cues (others eating and alone) as predictors of the likelihood of a data point being a high energy or low energy snack compared to a randomly prompted report (see Table 4). Observing others eating was the strongest predictor of snacking opposed to being alone. A data point is 4.15 times more likely to reference a *high-energy snack* than a random prompt when others are eating. Correctly predicting *low-energy snacking* over random prompts is 2.10 times more likely when others are eating. Being alone increased the odds of a *low-energy snack* by 31% but did not predict the likelihood of a data point referencing a *high-energy snack.* The confidence intervals include 1 indicating a possibility of there being no difference of being alone on the likelihood of high-energy snack consumption.

The random effects in Table 5 and 6 suggest that there are substantial differences between individuals with regards to the overall odds of snacking, hence a multilevel approach to the analysis is the most appropriate for this data. The intraclass correlation coefficient (ICC) of the number of *low energy* snacks consumed when others are eating, suggest 37% of the variance in low energy snacking is due to variation between participants. Similarly, 84% of the variance in the consumption of *low-energy* snacks when alone is due to individual differences on the participant level. The random effects in Table 3 suggest that there are substantial differences between individuals with regards to the overall odds of *high-energy* snacking. The intraclass correlation coefficient (ICC) for the number of *high energy* snacks consumed when others are eating, ρ=0.60 suggesting that over half of the variance in these snacking patterns is a result of individual differences. Similarly, 66% of the variance in *high-energy* snacking when alone can be attributed to differences between participants. It can be noted that there was significant residual variance (.31) for when others are eating, which indicates individual difference in regards to effects on eating high energy snacks.

Table 4

Summary of random effects multinomial logistic regression analysis: parameter estimates, standard errors and odds ratios of each covariate cueing high and low energy snacking intake.

Cues	High-Energy Snacks		Low-Energy Snacks	
	Parameter Estimate (*SE*)	Odds Ratio (95% CI)	Parameter Estimate (*SE*)	Odds Ratio (95% CI)
Others Eating	1.42 (0.11)***	4.15 (3.37, 5.11)	0.74 (0.15)***	2.10 (1.57, 2.79)
Alone	-0.01 (0.10)	0.99 (0.82, 1.21)	0.27 (0.12)*	1.31 (1.04, 1.65)

The initial analysis focused on BMI as a possible moderator between cues and the likelihood of snacking. Multilevel logistic regression was used to examine possible cross-level interactions between BMI and cues on the prediction of *low energy* snacking. BMI is not a significant predictor of differences in the average probability of *low-energy* snacking compared to random prompts, however significant interactions between BMI and the slope of *others eating* indicate that BMI scores can predict differences in the effects of the cues on snacking (see Table 5). There was a significant interaction between *others eating* and the likelihood of *low-energy* snacking, moderated by BMI (see Fig. 1). Participants with a higher BMI were more likely to consume a *low*-energy snack when they observed others eating. BMI did not moderate the relationship between *being alone* and the likelihood of *low-energy* snacking.

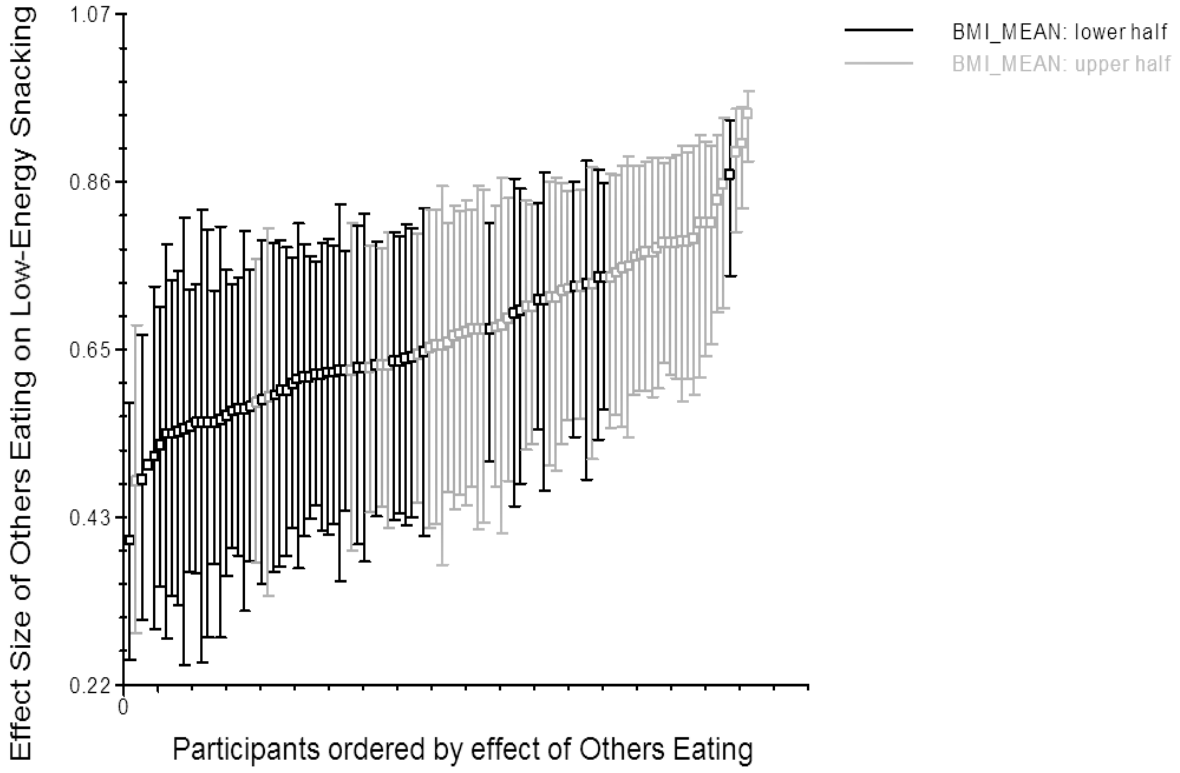

Figure 1. Effects of Others Eating on Low-Energy Snacks Ordered by Effect Size Smallest to Largest.

Table 5.

Odds Ratios of Cues (Within-Participants), Body Mass Index (BMI) Scores (Between-Participants) and Interactions Predicting Snacking (Reference Category = Random Prompts)

		Coefficient Estimates for Cues to Low-Energy Snacks			
		Alone (B, SE)	Alone (OR, 95% CI))	Others Eat (B, SE)	Others Eat (OR, 95% CI)
Fixed Effects	Intercept	-2.87 (0.26)***	0.06 (0.03, 0.09)	-2.93 (0.31)***	0.05 (0.03, 0.09)
	BMI*Intercept	-0.01 (0.01)	0.99 (0.96, 1.02)	-0.02 (0.02)	0.98 (0.96, 1.01)
	Slope Cue	0.27 (0.12)*	1.31 (1.04, 1.65)	0.74 (0.16)***	2.10 (1.57, 2.79)
	BMI*Slope Cue	-0.03 (0.02)	0.97 (0.93, 1.02)	0.07 (0.03)*	1.07 (1.01, 1.12)
Random Effects (Residual Variances)	Intercept	0.41***		0.39***	
	Slope Cue	0.08		0.67	

Note. *$p < .05$, **$p < .01$, ***$p < .001$

Multilevel logistic regression was also used to examine possible cross-level interactions between BMI and cues on the prediction of *high energy* snacking. BMI is not a significant predictor of differences in the average probability of *high-energy* snacking compared to random prompts. However, a significant interaction between BMI and the slope of *alone* indicates that BMI scores can predict differences in the cue effects on snacking (see Table 6). There was a significant interaction between *being alone* and the likelihood of snacking, moderated by BMI (see Fig. 2). Participants with a higher BMI were more likely to consume a *high-energy* snack when they were *alone*. BMI did not moderate the relationship between *others eating* and the likelihood of consuming a *high energy* snack.

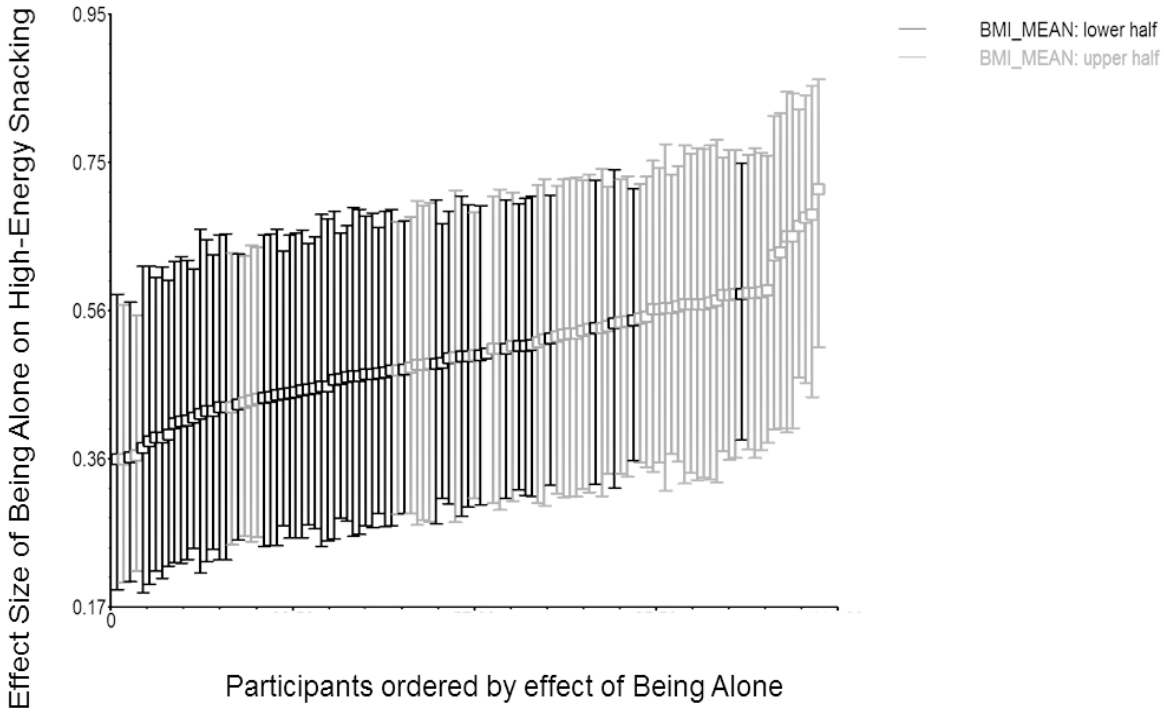

Figure 1. Effects of Being Alone on High-Energy Snacks Ordered by Effect Size Smallest to Largest

Table 6.

Odds Ratios of Cues (Within-Participants), Body Mass Index (BMI) Scores (Between-Participants) and Interactions Predicting Snacking (Reference Category = Random Prompts)

		Coefficient Estimates for Cues to High-Energy Snacks			
		Alone (B, SE)	Alone (OR, 95% CI)	Others Eat (B, SE)	Others Eat (OR, 95% CI)
Fixed Effects	Intercept	-1.78 (0.26)***	0.17 (0.10, 0.28)	-1.91 (0.27)***	0.15 (0.09, 0.25)
	BMI*Intercept	-0.01 (0.01)	0.99 (0.96, 1.02)	-0.01 (0.01)	0.99 (0.96, 1.02)
	Slope Cue	-0.01 (0.10)	0.99 (0.82, 1.21)	1.42 (0.11)***	4.14 (3.37, 5.10)
	BMI*Slope Cue	0.04 (0.02)*	1.04 (1.00, 1.01)	-0.01 (0.02)	0.99 (0.95, 1.03)
Random Effects (Residual Variances)	Intercept	0.41***		0.47***	
	Slope Cue	0.21		0.31*	

Note. *$p < .05$, **$p < .01$, ***$p < .001$

Discussion

This study examined whether there were BMI related differences in how people respond to social cues towards eating. Over a 14-day period, 112 non-clinical individuals from the general population used EMA devices to record their eating behaviours and social surroundings in real-time. As hypothesised, BMI moderated the effects of social cues on snacking. Participants with a higher BMI were more likely to consume low-energy snacks when others were eating compared to participants with a lower BMI. Participants with a higher BMI were more likely to consume high-energy snacks when alone than participants with a lower BMI. Others eating was the strongest predictor of snacking, complementary to Schuz et al. (2015) findings. Seeing others eat has been described as providing a social norm to guide eating behaviour. Schuz et al. (2015) found that an individual was five times more likely to eat when other were eating. Similarly, we found that four time more likely to snack when others were eating. Out of the three proposed theories of eating; modelling, social facilitation and impression management, the results from the current study are most fitting with impression management theories.

In the current study BMI moderated the relationship between others eating and low-energy snacks. Participants with a higher BMI were more likely to consume a low-energy snack when others were eating. These findings are explained by the research of Salmon et al. (2014), where participants with poor self-regulation relied on social cues as a guide to appropriate eating behaviour, resulting in participants choosing to eat the healthy option when others were present. The current study's findings are in line with theories of impression management that state individuals choose a healthier option to convey a favourable image of themselves.

BMI moderated the relationship between being alone and high-energy snacks. Participants with a higher BMI were more likely to consume high-energy snacks when alone.

These results support poor self-regulation in the absence of a normative comparison to guide eating behaviour. A relationship demonstrated in previous research, when normative cues were ambiguous participants were less likely to inhibit their eating behaviours. When acceptable normative behaviour was clear the participants reduced their consumption in line with confederate (Leone et al., 2007; Salmon et al., 2014). The current findings of BMI as a moderator between being alone and high-energy snack consumption is related to impression management. As there is no one towards whom they have to manage their impression they consume discretionary foods without fear of judgement. These findings are similar to Cheng et al. (2015) who demonstrated reduced impression management strategies in a private setting by comparing food choices with a public setting. Participants in the private condition were more indulgent in their food choices.

Although the data best fits with the theory of impression management modelling may have had an influence. Seeing someone else eating is essentially a food cue in itself and modelling the behaviour would facilitate eating. However, we did not collect data regarding the type of food that others were consuming to make an inferences about modelled behaviours. Also we did not include a measure of intake so we cannot compare if others eating influences consumption rate in line with the theory of social facilitation. Future research should include these measures in combination with BMI to further examine the relationship between BMI and social cues on eating behaviour.

The results of the current study indicate a difference between high and low BMI individuals in the way they respond to eating in the presence of others. This is supportive of Maykovich (1978) findings of obese participants eating less when others were present compared to when they ate alone. These impression management effects are only seen in obese individuals and not in normal-weight comparisons (Herman, 2015). The current study suggests that individuals with a higher BMI are more responsive to social eating cues. The

eating behaviours of participants with a higher BMI were influenced by the presence of others comparative to lower BMI participants. Salvy, Romero, et al. (2007) had similar result in a cohort of adolescent girls. They found that participants with a higher BMI were more susceptible to the eating behaviours of others around them and would alter their behaviour to match a normal-weight girl to give the impression she ate healthily.

Strengths and Limitations

This study is the first to have a dedicated look at BMI differences in cue effects in real time. A key strength of this study is that it was the first to examine BMI as a predictor of high and low energy snacking in the presence and absence of social cues using EMA technology. The data collection method EMA is an advantage over other self-report and recall methods. It provides a method of collecting the data close to real time (Thomas et al., 2011), as well as possibly reducing the limitations of traditional methods such as response and recall bias (Shiffman et al., 2008). Combining the snack logs and randomly prompted assessment provides a comparison of which to differentiate between the variables of the two contexts, specifically the social cues of others eating and being alone (Shiffman et al., 2008). The method of data analysis, multilevel logistic regression was a strength of this study. Allowing BMI to randomly vary we were able to investigate how individual weight differences influenced the cross level relationship between social cues and high and low energy snacks. This method provides information about the contextual influences for each individual so that it can be analysed in the hierarchical form that the data is structured in (Snijders & Bosker, 2012).

Despite these strengths this study has some limitations. Firstly, the sample consisted primarily of white and university educated participants, limiting the generalisability to the broader community. Replication with a more represented sample is warranted. Although

participants were directed to respond to question in relation to the moment they decided to eat, this assessment may be confounded by consumption prior to reporting. Also, when in a social context there may associated distractions such as conversation which result in underreporting of important social cues. Our data does not allow for monitoring of every snack consumed being logged. However, to reduce possible reporting bias one-on-one training was given to participants to ensure participants were familiar with study protocol and confident in the use of the EMA device.

To ensure the assessment process was not an inconvenience snack assessments were minimal. However, the options provided may have been too limiting and forced participants to choose an inappropriate option. A major limitation of this study is that snack assessment responses lacked caloric and nutritional information. Also we grouped the snacking option into high and low energy categories based on dietary recommendations. However, there may be a discrepancy between actual and perceived healthy snack options. Also, we did not account for habitual eating. Someone might eat at the same time every day but not perceive it as a meal, such as morning and afternoon tea. These eating times may be influenced by external factors other than social cues. For example, people often have allocated eating times at their workplace so are required to eat during those times and they may or may not have other employees allocated to the same time slot. In our study this may be misinterpreted as a social influence rather than the result of another external influence.

There are suggestions in the literature of snacking differences between gender and the weight and relation of an eating companion. Females with a high BMI are more susceptible to snacking energy dense food more frequently than males with a high BMI. Another trend in the literature is the relationship of the people present to the participants as an influence on eating behaviours. For example, individuals eating with people they know are more likely to experience social facilitation and people eating with strangers are more likely to experience

social suppression and engage impression management. Overweight and obese individuals are more likely to consume more when eating with others within the same BMI range comparative to normal-weight individuals. Due to practical restraints the current study did not examine these differences. Future studies should consider the nature of the relationship to further explore the influence of BMI predicting snacking in the presence of others. Similarly, differences in the BMI of others eating has been revealed to influence the participants eating behaviours. Future research should examine the role of the others BMI in relation to participant BMI on eating behaviour.

Implications and Conclusion

This study has important theoretical and practical implications. It provides important implications for the prevention and treatment of obesity. Our results stress the importance of social cues on eating behaviour and the importance of including BMI as a factor. Interventions should include raising awareness of the social influences on eating behaviour and the risk factor of being alone. Interventions should include self-regulation strategies to implement when alone to avoid over consumption of discretionary foods. This study also provides evidence towards the theory of impression management. Future studies and theories of eating behaviour should include BMI as a moderating factor. Using EMA methods had been a way to test lab based findings in the real world context. It has confirmed that individuals with an increase BMI are more likely to snack, putting themselves at increased risk of further weight gain and associated health problems.

This research has shown that individuals with a high BMI are more susceptible to eating energy dense foods when alone, putting them at risk for additional weight gain and associated health implications. It also supports the theory of impression management and reveals the direction of the relationship between the presence of others and snack choice

moderated by BMI. This research has highlight the importance of including BMI as a moderating factor.

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Table of Appendices

Appendix A
Ethics Approval Letter

Social Science Ethics Officer
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Tel: (03) 6226 2763
Fax: (03) 6226 7148
Katherine.Shaw@utas.edu.au
HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

1 April 2016

Dr Benjamin Schuez
Division of Psychology
University of Tasmania

Student Researcher: Thalia Papadakis

Sent via email

Dear Dr Schuez

Re: MINIMAL RISK ETHICS APPLICATION APPROVAL
Ethics Ref: **H0015647 - Individual, situational and normative predictors of food choices**

We are pleased to advise that acting on a mandate from the Tasmania Social Sciences HREC, the Chair of the committee considered and approved the above project on 31 March 2016.

This approval constitutes ethical clearance by the Tasmania Social Sciences Human Research Ethics Committee. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approval of other bodies or authorities is required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or human.ethics@utas.edu.au.

3. Incidents or adverse effects: Investigators should notify the Ethics Committee immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

4. Amendments to Project: Modifications to the project must not proceed until approval is obtained from the Ethics Committee. Please submit an Amendment Form (available on our website) to notify the Ethics Committee of the proposed modifications.

5. Annual Report: Continued approval for this project is dependent on the submission of a Progress Report by the anniversary date of your approval. You will be sent a courtesy reminder closer to this date. **Failure to submit a Progress Report will mean that ethics approval for this project will lapse.**

6. Final Report: A Final Report and a copy of any published material arising from the project, either in full or abstract, must be provided at the end of the project.

Yours sincerely

Katherine Shaw
Executive Officer
Tasmania Social Sciences HREC

Appendix B

Participant Information Sheet

Private Bag 30 Hobart

Tasmania 7001 Australia

Phone (03) 6226 7471 Fax (03) 6226 7471

Email Benjamin.schuez@utas.edu.au

SCHOOL OF MEDICINE, PSYCHOLOGY

PARTICIPANT INFORMATION SHEET

Individual and situational predictors of food choices

1. Invitation

You are invited to participate in a research study investigating the drivers ("predictors") and consequences of eating. The study is conducted by Dr Benjamin Schüz, Dr Stuart Ferguson, Dr Natalie Schüz and Thalia Papadakis from the School of Medicine of the University of Tasmania.

2. 'What is the purpose of this study?'

The purpose of the study is to examine eating behaviour in people with a normal – high BMI from the "input" perspective. This means that we want to examine the drivers and consequences of eating, in particular the consumption of energy-dense food. Data will be gathered on the individual (e.g., craving, hunger, mood), as well as social and situational (e.g., location, company) antecedents of eating, as well as how people feel after eating. Results from this research have the potential to influence the development of more efficacious treatments to support people with overweight and obesity in maintaining a healthy diet.

3. 'Why have I been invited to participate in this study?'

You are eligible to participate in this study because you have a BMI between 18 - 40, are over 18, and interested in contributing to research about eating patterns.

4. What will I be asked to do?

If you choose to participate in this study, you will be required to take part in 14 days of monitoring (explained below).

While in the study, you will be monitoring your eating / drinking patterns and your feelings as well as experiences as you go about your daily life. To do this, we will supply you with a simple to use hand-held computer – which looks very much like a smartphone. You will need to return this computer at the end of the study. You will be asked to carry this computer with you at all times for the duration of the 14 day study.

You will need to carry the device with you wherever you go at all days of the study and record and photograph each time you consume any food or drink. Some of these recordings will be randomly followed up by a brief assessment consisting of questions asking about the social, emotional, and situational environment of where you had food or a drink. You will also be asked to complete 4-5 assessments at random time points during the day. Each assessment will only take about 1-2 minutes to complete. During these assessments, the device will also automatically record the location you are at. We will provide you with training on how to use the device and will happily answer any questions you might have regarding participating in this study.

Participating in this study will also require you to visit the University of Tasmania up to three times for short study visits. One initial visit to enrol (approximately 45 minutes), and for two short (approximately 15 minutes) visits; the first around day three of participating, and a final visit on day 14 of the study. During the enrolment visit, you will receive training on how to use device and you will be asked to complete some baseline surveys to help us gather background information on your current and previous eating behaviour. At visit 2, three days into the study, the data will be downloaded from your devices and any additional questions you might have will be answered. During the final visit after 14 days, you will return the study device and will receive some debriefing regarding your experiences during the study. You will also be reimbursed $50 for your time and contribution to the research at this visit.

It is important that you understand that your involvement in this study is voluntary. While we would be pleased to have you participate, we respect your right to decline. There will be no consequences to you in you decide not to participate.

All information will be treated highly confidential, and your name or any identifying information will not be used in any publication arising from this research. All data will be analysed without identifying information so that at no time individual participants can be identified.

The research data will be kept in a locked file cabinet (hard copies) at the School of Medicine, and all electronic data will be kept on a password-protected computer. In accordance with National Ethics Guidelines, hard copy data will be kept for five (5) years before being destroyed. Electronic data will be securely stored until it is no longer needed.

5. Are there any possible benefits from participation in this study?

It is possible that the monitoring technology used in this study will help you learn more about your individual eating and/or drinking behaviour. Furthermore, the information we gather may be beneficial for other people by contributing to the development of future dietary management interventions.

6. Are there any possible risks from participation in this study?

There are no specific risks anticipated with participation in this study.

7. How will the results of the study be published?

When the study has been completed, the main outcomes will be published on the University of Tasmania's website and in scientific journal articles. We will also send you results of the study to the email address you have given us.

Your name will not be used in any publication arising out of the research.

8. What if I have questions about this study?

If you would like to discuss any aspect of this study please feel free to contact our team on (03) 6226 7471. We are happy to discuss any aspect of the research with you. You are welcome to contact us to discuss any issue relating to the research study.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 2763 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H0014439.

Thank you for taking the time to consider this study.

If you wish to take part in it, please sign the attached consent form.

This information sheet is for you to keep.

Appendix C
Consent Form

Private Bag 30 Hobart

Tasmania 7001 Australia

Phone (03) 6226 7471 Fax (03) 6226 7471

Email Benjamin.schuez@utas.edu.au

CONSENT FORM

Individual and situational predictors of food choices

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1. I acknowledge that the nature, purpose and contemplated effects of the project so far as it affects me, have been fully explained to my satisfaction by the study staff member and my consent is given voluntarily.
2. The details of the research have also been explained to me, including the anticipated length of time it will take, the frequency with which the assessments will be performed. I understand that my participation involves:

    - Fourteen (14) days of monitoring (explained below). While in the study, I will be asked to monitor my eating and drinking behaviour and associated questions using a hand-held computer. I understand that my participation involves carrying this device with me at all times for the duration of the 14 day study.
    - Three study visits to the University of Tasmania campus, each of which will take between 15 and 45 minutes to complete;
    - The completion of a baseline questionnaire (assessing current diet, diabetes illness perceptions, demographics, and mood questionnaires) during the initial visit.
    - Being reimbursed $50 upon completion of the third visit and return of device to compensate for my time.

3. I understand that there are no risks anticipated from my involvement in this research.

4. I understand that my involvement in the project will not affect my relationship with my medical advisers in their management of my health. I also understand that I am free to withdraw from the project at any stage and any of my data/specimens that have been collected. My withdrawal will not affect my legal rights, my medical care or my relationship with the hospital or my doctors.

5. I understand that I will be given a signed copy of the participant information sheet and consent form. I am not giving up my legal rights by signing this consent form.

6. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years and will be destroyed when no longer needed.

7. I understand that research data gathered from me may be published, provided that I cannot be identified as a person.

8. I understand that the researchers will maintain my identity confidential and that any information I supply to the researchers will be used only for the purposes of this research.

9. I understand that the research will be conducted in accordance with the latest versions of the *National Statement on Ethical Conduct in Human Research 2007* and applicable privacy laws.

10. Any questions that I have asked have been answered to my satisfaction.

Name of participant

Email address (if we need to contact you):

Signature of participant

Date

I have explained this project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

Name of investigator

Signature of investigator

Date